

**Federal Aviation Administration**  
**William J. Hughes**  
**Technical Center**



*Second Edition*



# Executive Summary

*The William J. Hughes Technical is one of the world's leading engineering, research, development, and testing facilities for nearly every aspect of aviation. Here, the air traffic control (ATC) automation, communications, navigation, and surveillance systems needed to modernize the National Airspace System (NAS) are tested and evaluated for deployment. Advanced air traffic management (ATM) technologies for the next century are developed and evaluated in a high-fidelity ATC laboratory environment with air traffic controllers.*

## *William J. Hughes Technical Center Mission*

"To provide engineering and research expertise in an integrated laboratory environment for the development and support of a safe, secure, modern, and efficient global aviation system."

## *Unique Combination*

The Technical Center is known for its unique laboratories and high-fidelity test facilities used for research, development, test, and evaluation of aviation systems. The unique combination of expert personnel and high-fidelity laboratories at a centralized location makes the Technical Center the ideal place to conduct applied research for developing new, advanced air traffic and airway facilities systems.

Our fully integrated network of specialized laboratories offer state-of-the-art equipment and facilities dedicated exclusively to developing aviation systems and technologies. However, the most important resources at the Center are the engineers, scientists, computer specialists, human factors specialists, air traffic control specialists, technicians, and support staff who have the expertise to use these facilities.

## *Aviation Safety and Security*

The Federal Aviation Administration's commitment to aviation safety and security is paramount. Research and development programs conducted at the Technical Center's laboratories and test facilities are the basis for aircraft safety specifications, procedures, and regulations. The latest technologies to neutralize the threat of terrorist attacks against civil aviation are being researched and developed here in the Aviation Security Laboratory.

## *From Concept to Final Product*

The Technical Center supports all stages of research and acquisition from concept exploration, system development, and operational test and evaluation to field implementation. The Technical Center provides an environment in which one can explore, integrate, and test new air traffic control systems. Our NAS testbeds are used for every type of test and evaluation needed to ensure that new systems, and enhancements to existing systems, are safe for national deployment. On-site air traffic controllers, simulation experts, human factors specialists, pilots, and technicians provide assurance that testing and evaluations represent real-world operations.

## *State-of-the-Art Capabilities*

We possess extraordinary simulation and test capabilities with the ability to link individual laboratories to produce a wide variety of airspace environments. Through versatile wide-area and local data communications networks, our labs and testbeds can be integrated with other laboratories, actual NAS facilities, and aircraft to evaluate essentially any conceivable air traffic concept. Our extensive data-sharing capabilities allow for testing to be conducted on a real-time basis by incorporating both in-house and remote flight simulators, weather, communications, navigation and surveillance systems.

## *A Commitment to the Future and to The Year 2000 (Y2K)*

Our primary task for the past three decades has been modernizing the NAS to ensure safe and efficient civil air transportation as utilization continues to grow. Currently a major priority is updating existing systems to assure the Y2K compliance for all mission critical components. The Technical Center provides the primary testbeds for validation testing of operational systems and new systems currently under development. We are committed to continuing a tradition of providing high-quality services and products needed for the NAS into the next century.



# NAS Modernization

*The FAA's goal in system efficiency is to "provide an aerospace transportation system that meets the needs of users and is efficient in the application of FAA and aerospace resources." The Technical Center conducts engineering, research, development, and testing activities that encompass every aspect of air traffic operations, using both currently fielded and newly developed systems.*



## Terminal Air Traffic Control

The terminal areas are under intense pressure to safely and efficiently handle the ever-increasing congestion of flights. We offer the most cost-effective means for studying new operations concepts and advanced aviation technologies to alleviate this capacity burden. Our laboratories contain both current and advanced radar display systems for testing and developing air and ground traffic procedures. Simulations conducted at the Technical Center facilitated the first ever triple parallel approach operations, the development of the airspace design and procedures for the new Denver International Airport, and triple-parallel approaches in Dallas-Ft. Worth under the new metroplex airspace configuration. The Standard Terminal Automation Replacement System (STARS) is one of several new air traffic control systems currently being evaluated at the Technical Center.

## En Route Operations

The Technical Center en route laboratories include two Host Computer Systems with peripheral devices that can support up to 22 Air Route Traffic Control Center (ARTCC) radar controller positions. This expansive capability can be used to evaluate the latest proposed operational concepts. Field support and testing are the primary functions of these laboratories. All changes to the host software and interfaces are evaluated here to ensure that an acceptable level of performance and system integrity are maintained. The Display System Replacement (DSR)/Display Channel Complex Rehost (DCCR) equipment, currently in the Technical Center's laboratories, will be replacing the aging Plan View Displays (PVDs) with new, open systems architecture.



## Oceanic Operations

Developing the oceanic air traffic control system and procedures are major areas of focus. Our NAS laboratories house two oceanic systems, the Oceanic System Support Facility (OSSF) and the Oceanic Development Facility (ODF). The OSSF is used for field support and for testing new oceanic air traffic control systems. The ODF is a real-time dynamic test driver for the OSSF. With oceanic airspace linking the Continental United States with the rest of the world, these systems are a valuable asset for exploring new concepts and technologies needed to meet growing global air travel demands.



# Services and Operations

*A flight from Denver, Colorado, to Tokyo, Japan, via New York and Paris exemplifies the scope of our testbed capabilities. Every NAS service provided by the FAA is either on-site or accessible at the Technical Center.*



## Flight Testing

The Technical Center operates a fleet of specially equipped aircraft that range in size from small planes to helicopters to large transports. These "flying laboratories" are used to test new airborne equipment and operational procedures.

## Flight Services

From jumbo jets to recreational general aviation, the Technical Center is developing the latest technology to modernize flight services. New weather processors, radar, displays, and communications systems are continually being engineered, tested, and evaluated in our laboratories. Flight plans, pilot briefs, Notices to Airmen (NOTAMS), and other FAA services are moving to open-systems networked computer architectures to provide highly accessible information as fast as you can click a mouse on your personal computer.

## Integration and Interoperability Facility

The Integration Interoperability Facility (I<sup>2</sup>F) at the Technical Center provides a complete DSR-based en route system environment to perform research development and integration of new, as well as existing, ARTCC systems. Developers explore issues associated with modernizing the existing NAS en route infrastructure. The I<sup>2</sup>F streamlines ATC system development and alleviates the burden and expense of conducting prototype-related activities in an ARTCC. This facility can be used to perform experiments, studies, evaluations, system-level integration, and verification and validation without the risk of impacting air traffic operations and without requiring site personnel to operate and maintain the equipment.

## Weather

Weather is a major concern to aviators. Wind shear, hurricanes, tornadoes, and other weather conditions affect both flight safety and capacity. The Technical Center's simulation capabilities, on-site weather systems, and network access to other weather data providers make it possible to safely measure the impact of hazardous weather conditions on en route flight, terminal air traffic, and airport ground traffic.



# Air Traffic Management

*The airlines, air traffic controllers, and the flying public will all benefit from the emerging Air Traffic Management (ATM) technologies. Powerful ATM algorithms will use flight plans, real-time and highly accurate position data, and weather information to model aircraft trajectories and probe for conflicts to ensure safe aircraft separation is maintained. The future ATM system will be a collection of integrated automated tools that will greatly increase NAS efficiency.*

## Air Traffic Management Capabilities

An essential research and test environment for air traffic prototype development is our Traffic Flow Management Laboratory. This laboratory interfaces with actual NAS data providers, such as the Host Computer System (HCS), Automated Radar Terminal System (ARTS), and the National Weather Service (NWS). As a result, new concept prototypes are integrated in realistic operational environments which allow for early deployment to FAA field sites.



## Rapid Prototyping

Rapid prototyping of air traffic control tools makes it possible to study new ATM computer displays and operational concepts and to validate system requirements. Through this "fast-tracked" development approach, controllers, airlines, and the flying public realize early benefits of the latest technologies. Prototypes are integrated, matured, and evaluated for deployment into operational field sites via high-fidelity simulations. Ongoing accomplishments in rapid prototyping are the results of our collaborative efforts with NASA, the Volpe Transportation Center, MIT Lincoln Laboratory, Mitre, and other industry partners.

## The Future is Here!

Prototype ATM tools deployed in Miami, Atlanta, Dallas-Ft. Worth, Denver, Indianapolis, and Los Angeles are already saving the airlines fuel and have safely increased airport capacities without adding runways or increasing controller workload. Several research and development activities are being planned, or are already underway, to incorporate these ATM tools with the latest ATC systems. STARS, the Display System Replacement (DSR), and Safe Skies 21 are some of the projects slated for ATM tool integration and evaluation. With an eventual gate-to-gate ATM system, passengers will enjoy delay-free air travel while airlines safely operate in an extremely flexible, accommodating, and efficient airspace.





# Human Factors

*Human factors pursues the seamless integration of people, equipment, and procedures... applying principles from the behavioral sciences to system engineering to optimize job performance. The Technical Center researchers strive to improve human performance in the NAS. Our Research, Development, and Human Factors Laboratory (RDHFL) scientists conduct experiments, studies, and simulations to explore multiple "what if" scenarios related to various aspects of air traffic operations.*



## Air Traffic Control Research & Applications

Our human factors specialists are currently evaluating the next generation air traffic control displays and workstations. In the Human Factors Laboratory, they investigate the effects of increasing automation and emerging technologies on air traffic controllers in high-fidelity, simulated environments using the latest human performance measurement techniques. The Virtual Environment and Advanced Visualization Laboratory, reconfigurable experiment rooms, and the audiometric booth are some of the state-of-the-art research tools used in our search for the best human-machine interface. The program includes developing research methods and metrics and then applying them to study specific air traffic control, communications, navigation, and surveillance systems. The air traffic simulators can also be linked to cockpit simulators for studying the integration of air and ground systems.

## Airway Facilities Research & Applications

In the future, managing and maintaining the NAS will increasingly rely on the automation of Airway Facilities systems. High system reliability, maintainability, and availability are critical to NAS operations and safety. The Operations Control Center (OCC) of the 21st century is the focus of our human factors researchers. Research involving the latest developments in remote maintenance monitoring and control technology is underway to ensure that the NAS is always on line. The program includes developing Human Factors Design Guides, evaluating and improving computer-human interfaces, assessing the potential for system-induced operator errors and developing mitigation strategies, and exploring the application of interactive voice technology and artificial intelligence.

## Flight Deck Evaluations

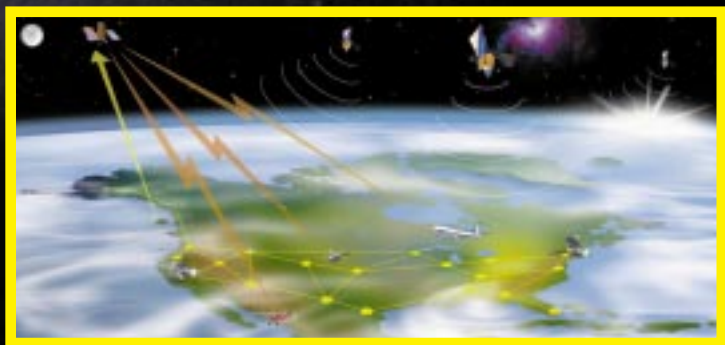
Our Reconfigurable Cockpit Simulator (RCS) can simulate virtually any aircraft flight deck. Graphical representation of cockpit displays, instrument panels, and out-of-window displays are used to replicate the flight deck environment during actual flight.





# Navigation and Surveillance

*The science of navigation has come a long way from the days when ship captains charted their course by the stars. Navigation by satellite is now a reality. It allows pilots and air traffic controllers to pinpoint an aircraft's position to within one hundred feet anywhere on the globe. The William J. Hughes Technical Center researchers and system developers are bringing this emerging navigation and surveillance technology into the NAS.*

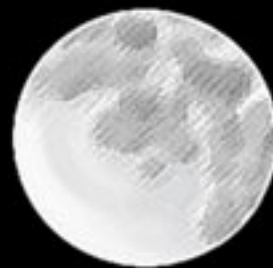


## Global Positioning System (GPS)

Whether it's to help guide a pilot through a precision approach or navigate an aircraft anywhere in the world, the 24 GPS satellites and ground-based augmentation stations of GPS provide the most accurate navigation system ever devised. Distributing GPS corrections and system status over the Local Area Augmentation System (LAAS) and Wide Area Augmentation System (WAAS) will reduce flightdeck and controller workload by creating a seamless navigation system and reducing the required on-board navigation systems. Technical Center scientists and engineers conduct flight tests with actual GPS signals and prototype ground stations, which increase GPS accuracy even further. Our aircraft fleet, which is specially equipped with atmospheric and redundant precision navigation instrumentation, is used to evaluate GPS integration with new, satellite-based avionics. GPS/LAAS/WAAS capabilities are ideal for improving safety in the areas of surface navigation, obstacle and terrain clearance, instrument approaches, and in-flight separation. It will be a key element of the Automatic Dependent Surveillance-Broadcast (ADS-B) architecture.

## Automatic Dependent Surveillance-Broadcast (ADS-B)

Automatic Dependent Surveillance-Broadcast (ADS-B), the next generation of Automatic Dependent Surveillance (ADS), will provide aircraft position data to both airborne and ground-based users. ADS accurately and automatically communicates aircraft position over domestic, oceanic, or non-radar environments and provides that information to air traffic controllers. Currently the Radio Technical Commission for Aeronautics (RTCA) committee is developing operational requirements and minimum performance standards for ADS-B. Our communications, navigation, and surveillance testbeds create the ideal environment to evaluate new ADS technologies.



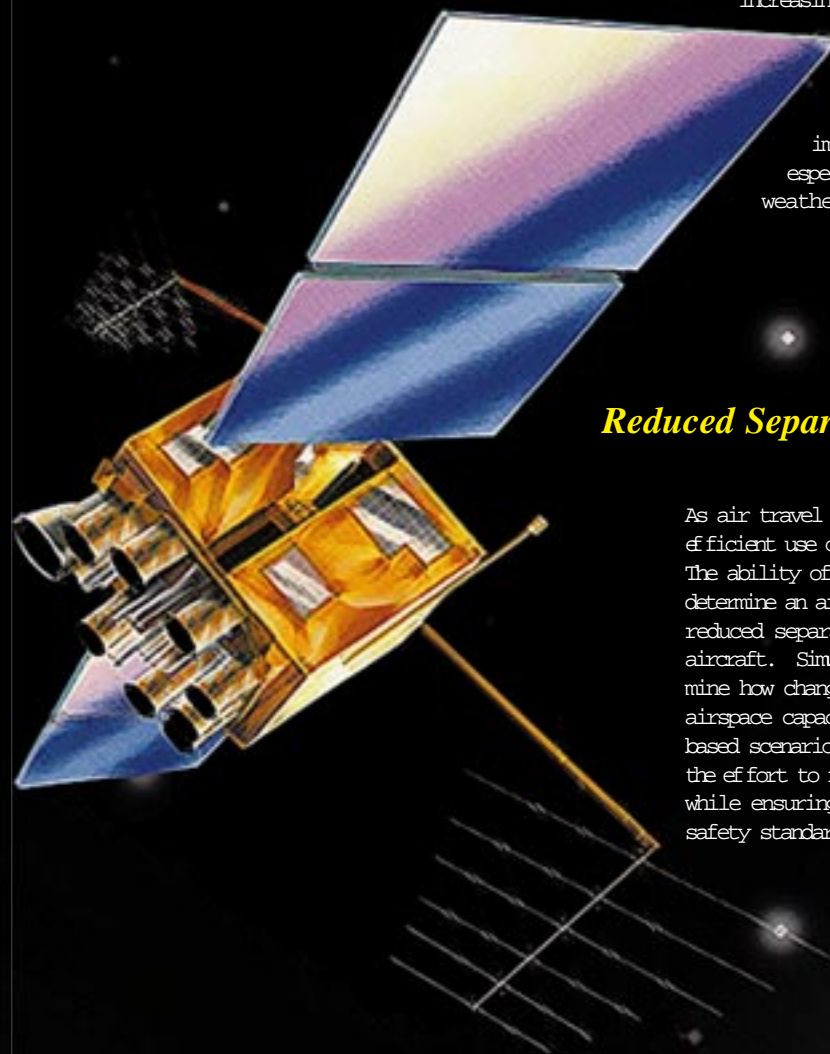
## Precision Approaches Using GPS

GPS/LAAS/WAAS will enhance terminal airspace operations by increasing the number of airports where precision approaches can be flown. As a result, greater NAS efficiency can be realized by increasing capacity at these airports.

Through simulations and flight testing, researchers evaluate how GPS-based avionics safely help to improve terminal operations, especially during inclement weather.

## Reduced Separation

As air travel continues to increase, more efficient use of airspace is imperative. The ability of GPS signals to precisely determine an aircraft's position will permit reduced separation between any pair of aircraft. Simulations are used to determine how changes in separation will affect airspace capacity. In our labs, computer-based scenarios provide a useful tool in the effort to relieve airspace congestion while ensuring conformance to existing safety standards.



## Primary and Secondary Surveillance

Whether an aircraft is moving on the ground or airborne, a key aspect of air traffic control is knowing the location of each airplane. The Airport Movement Area Safety System (AMASS), new Airport Surveillance Radar (ASR-11), and Air Traffic Control Beacon Interrogator are a few of the latest surveillance systems which will be introduced into the NAS. As with the predecessor radar systems, the Technical Center will again take the lead responsibility for testing and evaluating these new systems.



# Communications

# Terminal Areas

*From a controller's voice to the digital transmission of weather and aircraft position data, communications play a central role in every aspect of aviation. As today's radio-based analog systems yield to improved digital communications, the Technical Center's capacity to provide simulated and live environments integrating satellites, computers, avionics, and voice communications offers unparalleled research, development, and testing capabilities.*



## Data Link

As controllers and pilots rely more on data messages and less on voice communications, a major challenge is improving aviation safety, capacity, and efficiency without increasing their workload. The Technical Center is meeting this challenge with state-of-the-art communications laboratories that are interconnected with cockpit simulators, actual aircraft, and air traffic control facilities.

## NEXCOM

The FAA plans to replace the current air to ground communications system with the Next Generation Air/Ground Communications (NEXCOM) system. Advances in digital processing and data transmission technologies are being applied to the very high frequency (VHF) aeronautical band to increase voice and data throughput capacity and quality. NEXCOM will provide flexible and highly reliable spectrum-efficient communications services between ground-based facilities and aircraft. Being the home of many current and future NAS elements, the Technical Center will play an important role in developing and implementing NEXCOM.

*Airports today face an increasing number of economic and geographic barriers that limit growth. Meeting tomorrow's needs requires changes in takeoff and landing patterns and improved lighting and visual aids, as well as new procedures that can enhance the efficiency of existing facilities. To help accomplish these goals, the William J. Hughes Technical Center provides simulation tools, test environments, and expertise that will lead researchers and system developers to technological breakthroughs that will effectively increase airport capacity while ensuring public safety.*

## Airport Capacity Simulations

As a way of exploring methods of enhancing airport capacity, computer models have been developed that simulate an airport's operations. Through modeling, specialists are able to determine how changes in taxiways, lighting systems, and other airport and airspace improvements can increase airport capacity and reduce delays.



## Airway Facilities Tower Integration Laboratory (AFTIL)

The Airway Facilities Tower Integration Laboratory (AFTIL) is a state-of-the-art air traffic control tower laboratory that provides realistic, flexible, and controlled tower environments for the analysis of transition and implementation issues. It also provides a mock-up of cab consoles and floor areas for operations and human factors evaluations. This facility has an Out-the-Window Display System with site-specific simulation scenarios that offer a realistic view of the surrounding environment as seen from the tower cab. Air traffic control tower operations are simulated in order to determine equipment and procedural strategies, support engineering, development, and implementation issues of new systems to be integrated into the overall tower environment.



# Safety and Security

*The William J. Hughes Technical Center is the scientific mecca for FAA engineering research, development, testing, and evaluation. We are involved in every aspect of flight, putting our resources to work across a broad spectrum of aviation-related areas.*

## Aviation Security

The Aviation Security Improvement Act of 1990 authorized the FAA to pursue a more rigorous program to employ new, state-of-the-art technologies to prevent, counter, and respond to terrorist activities. In an effort to protect the American flying public from terrorist attacks, through a combination of simulation and live testing, The Aviation Security Laboratory, located at the William J. Hughes Technical Center, conducts a full range of experiments to bring the latest security technology to airports and aircraft. The FAA is promoting the development of explosives and weapons detection, aircraft hardening, human factors, and security technology integration to provide the civil aviation system with maximum security while minimizing adverse impacts on airlines and airport operations.



## Aviation Safety Research and Development

Fire and accident testing on aircraft, components, and engines require very specialized facilities and experienced people. The Technical Center has the world's largest full-scale aviation fire test facility, as well as an aircraft components fire test facility, wind tunnels, chemistry laboratory, engine test cells, impact test facility, and fuel safety laboratory.

A recent addition to our R&D repertoire is the National Airport Pavement Test Facility. Scientists and engineers from the United States and other countries will use this unique facility to explore and validate new pavement designs, construction methods, and paving materials.

Another new addition to the aircraft safety area is the Full-Scale Curved-Panel Test System. This state-of-the-art apparatus is used to test full-scale aircraft curved fuselage panels under axial, shear, and pressure loading. It is also used to test damage initiation, propagation, and residual strength of various configurations, and to validate structural analysis techniques. This will give engineers and researchers a new and powerful tool for developing methods and procedures used to predict the onset of wide-spread fatigue damage.





# *Working Together*

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## *Software Engineering Resource Center*

The William J. Hughes Technical Center is an integral part of the FAA's Software Engineering Resource Center (SERC). The SERC has been established to improve the FAA's software technology base and software engineering competencies. Leveraging expertise from government, academic, and industry sources, the SERC serves as a focal point for solving mission critical software problems, conducting software and systems engineering research, and providing unique educational opportunities for FAA personnel.

## *International Agreements and Inter-Agency Agreements*

The Technical Center has international agreements with the Netherlands, Great Britain, Israel, Canada, and Germany. We also maintain inter-agency agreements and memoranda of understanding with many federal government agencies, including branches of the military, the Department of Energy, the National Weather Service, and the National Aeronautics and Space Administration. Under these agreements we conduct research in the areas of data link communications, air traffic control and traffic management, maintenance procedures, air traffic safety, and international regulations and standards.

## *Technology Transfer, Grants, and Centers of Excellence*

The Technical Center provides leadership in many aviation-related education and research programs. In compliance with the Federal Technology Transfer Act, these programs yield the benefits from sharing technology among federal laboratories, private industry, colleges, and universities. Cooperative Research and Development Agreements, aviation research grants, and Centers of Excellence position the FAA for receiving and transferring emerging aviation technologies to the federal and private sectors. Integral to fulfilling the Technical Center's mission, these programs enhance our knowledge base and afford us the opportunity to work closely with some of the brightest minds in academia and industry.

## *Teaming with Industry*

Many of our air traffic control industry partners have used the William J. Hughes Technical Center's resources and capabilities in collaborative engineering, testing, research, and development efforts. NASA, Massachusetts Institute of Technology/Lincoln Laboratory (MIT/LL), the Volpe National Transportation Systems Center (VNTSC), and FAA contractors are some who work closely with us on various projects.



# Directions

William J. Hughes Technical Center

## From New York City

Take Garden State Parkway south to Exit 38A (Atlantic City Expressway - Philadelphia) proceed to Exit 9W and follow signs to the FAA William J. Hughes Technical Center.

## From Washington, D.C./Baltimore

Take I-95 north to NJ route 40. Follow route 40 east to route 322, and follow signs to the FAA William J. Hughes Technical Center.

## From Atlantic City

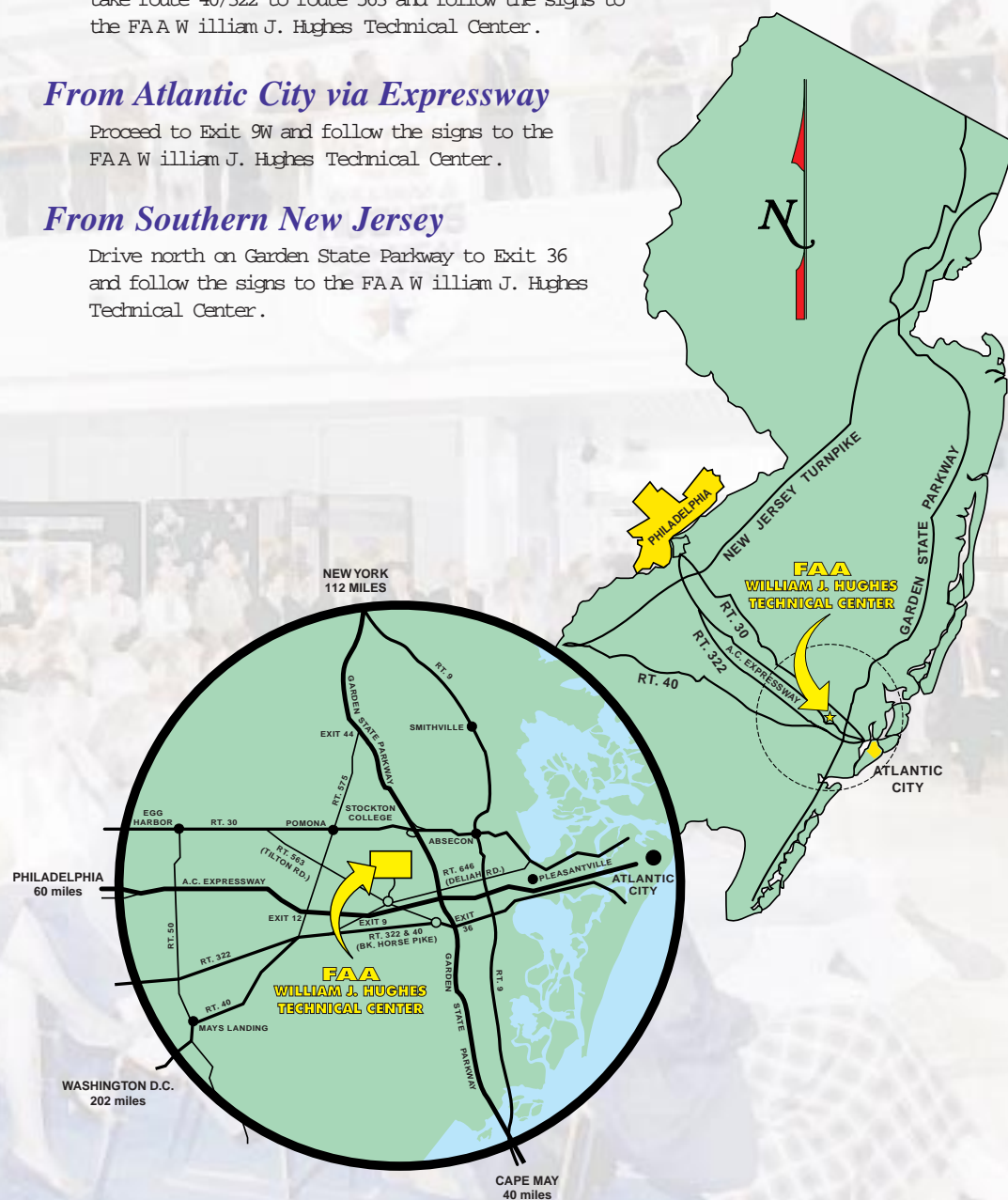
Travel west on route 30 for about 12 miles to Pomona or take route 40/322 to route 563 and follow the signs to the FAA William J. Hughes Technical Center.

## From Atlantic City via Expressway

Proceed to Exit 9W and follow the signs to the FAA William J. Hughes Technical Center.

## From Southern New Jersey

Drive north on Garden State Parkway to Exit 36 and follow the signs to the FAA William J. Hughes Technical Center.



# Points of Contact

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www.tc.faa.gov



*For more information about the William J. Hughes Technical Center*

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*U.S. Department of Transportation  
Federal Aviation Administration*